The Hydro-Møller device in the polarimeter chain for the MESA-PV experiment

SOLID „Dry-run“
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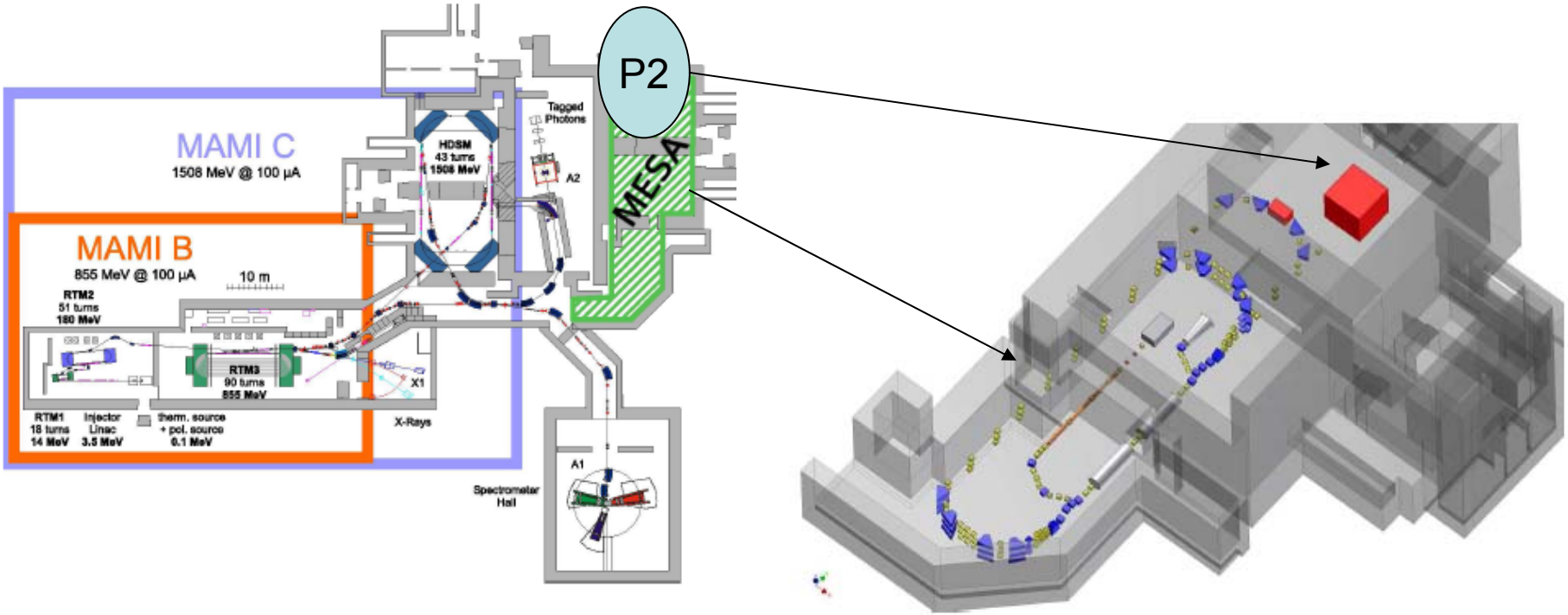
P2 collaboration
at IKP Mainz

P2-Project at Mainz- project rationale

- P2 is “Q-WEAK with improved systematics & statistics”
- low beam energy → low γ-Z box graph contribution
- low momentum transfer → low form factor contribution
- better statistics possible due to minimized accelerator running costs & priority access to machine - especially if dedicated accelerator – MESA – becomes available….)



MESA is favorable, but not mandatory for P2 ! (also possible: 180 MeV from MAMI-A)

P2-Project at Mainz: Polarimetry

- reduced systematics calls for improved polarimetry.
- "Unimpeachable" polarization measurement: by two independent polarimeters with $\Delta P/P < 0.5\%$ each.

But how? (One possible option – Laser Compton - will not work at ~200 MeV)

Proposed solution:

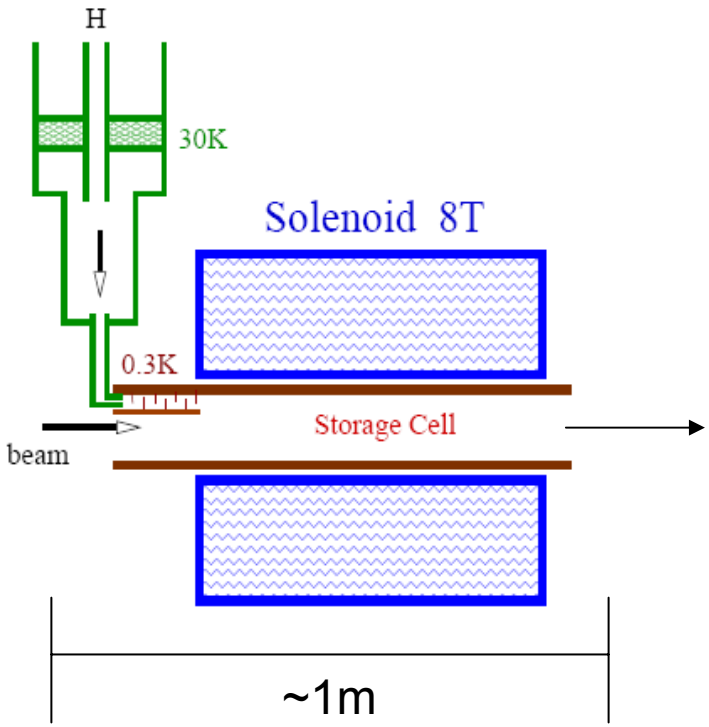
1) Double scattering Mott polarimetry – self calibrating
   DSP claimed accuracy in effective analyzing power is < 0.3% - Experiment at Münster University (1994) Note: DSP works only at source energy - 0.05-0.3 MeV
2) Hydro Möller
   -circumvents Target polarization error and eliminates Levchuk-effect
   - suitable for online measurement and good statistics under P2-conditions in front of experiment. Collaboration with SOLID polarimetry group established.

Measures taken:

1.) DSP has been acquired from U-Münster, is installed at test- source in Mainz, measurements start these days.
2.) Hydro Möller atomic trap is available UVA (thanks: Don Crabb) has been sent to Mainz yesterday…

Hydro-Möller-trap: principle

Usage of atomic trap for polarimetry suggested
Chudakov&Luppov, Proceedings IEEE Trans. Nucl. Sc. **51**, 1533 (2004)



Solenoid traps pure H↑ which has a long lifetime due to He-coating of storage cell. All other species are removed quickly from the trap.
→1-ε Polarization can be reasonably well estimated, but measurement difficult.
→ since $\varepsilon \sim 10^{-4}$ even 100% error in ε is tolerable…

Hydro-Möller-trap: prototype

UVA –prototype (W.A. Kaufmann et al.

NIM A 335 (1993) 17-29)

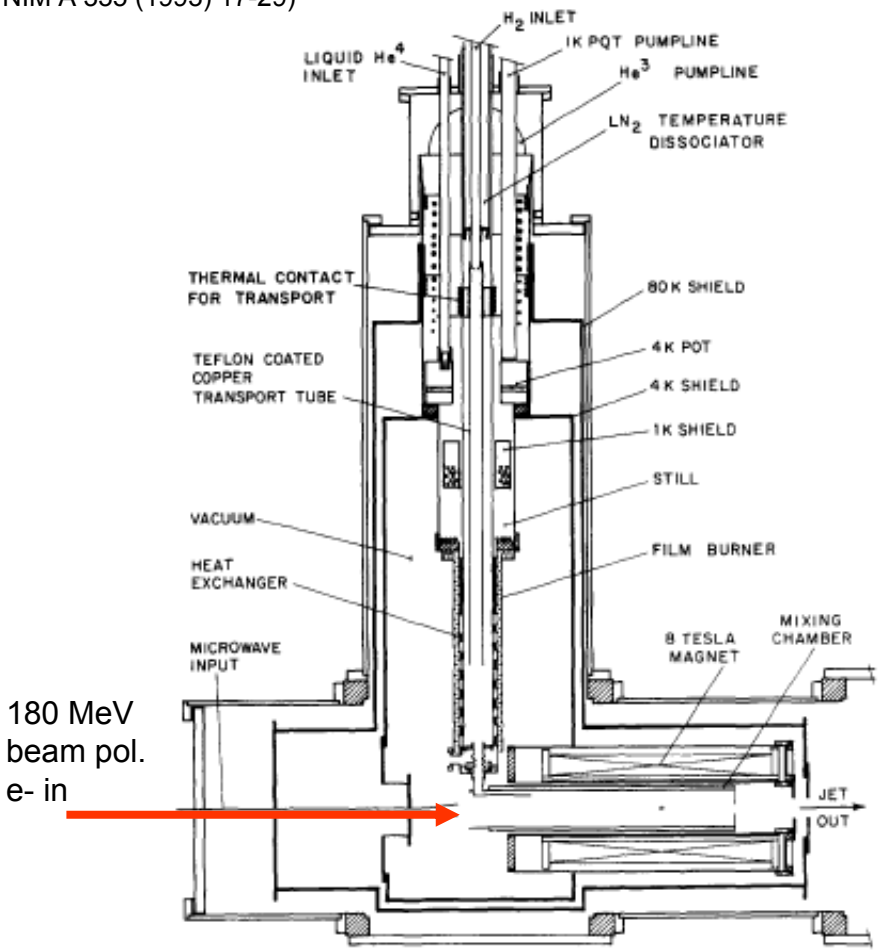


Fig. 4. Schematic diagram of the apparatus showing the vertical dilution refrigerator with the horizontal mixing chamber, the solenoid magnet, and the microwave and hydrogen feed.

Basic features of trap

- Solenoid only provides axial trapping
- radial enclosure by suprafluid helium film ~0.35K
  → 3He/4He dilution cryostat
- sufficient density achievable,
- electronic polarization $1-\varepsilon$; $\varepsilon \sim 10^{-4}$

Note: Trap was build with intention to achieve nuclear polarization for storage ring experiment

Hydro-Möller: project staging

Next Goals at Mainz (first CRC period until 2015)

- Get trap running
- (high lq. He consumption of prototype can be handled by available liquifier)
- Test atomic polarization in MAMI-A beam under P2-conditions 200μA/200MeV
- conclusions for final device to be operated at 0.2 and 12 GeV

Envisaged Project timeline

- 2012 staff hired, installations
- 2013: trap operating
- 2014: trap in beam
- 2015 conclusions: final design and ordering
- 2016 device ready for P2
- 2017 MESA operation, P2 experiment begins